IS 4258 (2011): Metallic Materials – Conversion of Hardness Values [MTD 3: Mechanical Testing of Metals]

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IS : 4258 - 1982
(Reaffirmed 2003)
Edition 2.1
(1984-12)

Indian Standard

HARDNESS CONVERSION TABLES FOR METALLIC MATERIALS

(First Revision)

(Incorporating Amendment No. 1)

UDC 669:620.178.1(083.5)

BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

Price Group 3

Indian Standard

HARDNESS CONVERSION TABLES FOR METALLIC MATERIALS

(First Revision)

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Indian Standard

HARDNESS CONVERSION TABLES FOR METALLIC MATERIALS

(First Revision)

0. FOREWORD

0.1 This Indian Standard (First Revision) was adopted by the Indian Standards Institution on 12 April 1982, after the draft finalized by the Methods of Physical Tests Sectional Committee had been approved by the Structural and Metals Division Council.

0.2 This standard was first published in 1967. This has now been revised in the light of the latest technical data available on the subject. In this revision, the comparison of hardness values and tensile strength for steels have been incorporated, as well as the comparison between the Brinell hardness, Vickers hardness, Rockwell hardness (in A, B, C, D and F scales) and the superficial Rockwell hardness numbers have been introduced.

0.3 Conversion of hardness values should be used only when it is impossible to test the material under the conditions specified, and when conversion is made it should be done with discretion. Each type of hardness test is subjected to certain errors, but if precautions are carefully observed, the reliability of hardness readings will be found comparable.

0.4 The conversion values specified in the tables are only approximate. It is emphasized that there are a number of factors which may influence the accuracy of a hardness test. Moreover, departures from the test conditions, namely, load, size of indentor, testing procedure used in deriving these tables may affect the accuracy of the hardness conversions.

0.5 The experimental data has shown that, for practical purposes certain simplifications may be made in deriving hardness comparisons for different materials. For example, it has been found that the conversion from Brinell to Vickers hardness numbers for aluminium and its alloys, brass and steel may be represented by the approximate relationship HB = 0.95 HV. Similarly, for the same materials the conversions from Vickers to the Rockwell B scale may be represented by a single curve.

0.6 The conversion tables, specified in this standard are applicable for steel, copper and brass (up to 30 percent zinc) and aluminium and aluminium alloys only. For materials other than those covered by this standard, hardness conversions should be avoided, unless a reliable basis for conversion is established.

0.7 The conversion tables, included in this standard are based on the following standards:

DIN 50150 Conversion table for vickers hardness, brinell hardness, rockwell hardness and tensile strength. Deutscher Normenausschuss.

BS 860 : 1967 Table for comparison of hardness scales. British Standards Institution.

0.8 This edition 2.1 incorporates Amendment No. 1 (December 1984). Side bar indicates modification of the text as the result of incorporation of the amendment.

0.9 In reporting the result of a test or analysis made in accordance with this standard, if the final value, observed or calculated, is to be rounded off, it shall be done in accordance with IS : 2-1960*.

1. SCOPE

1.1 The conversion tables given in this standard present data on the relationship among the Brinell hardness, Vickers hardness and Rockwell hardness and apply to the following materials:

a) Unalloyed and low alloy steels and steel castings in hot-worked or heat treated condition like forged, annealed, normalized and quenched and tempered conditions provided that they are homogeneous. For steels, the relationship between tensile strength and the different scales of hardness are also indicated (*see* Table 1);

b) Aluminium and aluminium alloys (*see* Tables 2 and 3); and

c) Copper and brass (up to 30 percent zinc) (*see* Table 4).

2. CONVERSION

2.1 Conversion, for the purpose of this standard, means to give for a hardness value, experimentally determined according to a particular method, the corresponding hardness value for another method, or the corresponding tensile strength value (in the case of steel only), as given in this standard.

*Rules for rounding off numerical values (*revised*).

2.2 Hardness Conversion — Hardness conversion shall be done only if the prescribed test method cannot be used, for example, when no proper testing machine is available or the test specimen does not suit the testing machine or if it is not possible to obtain the necessary test pieces (for example tensile test pieces) from the test article.

2.3 Hardness or tensile strength values, that are only indirectly determined with the help of this standard, may be used for claims, only if this is specifically agreed upon between the manufacturer and the supplier of the product. If hardness or tensile strength values are obtained by conversion in accordance with this standard, this fact shall be indicated in the test report.

2.4 For the purpose of conversions, the mean of at least three individual values of hardness shall be taken.

2.5 Conversion of Hardness Values to Tensile Strength Values for Steel — Due to the difference in deformation characteristics of the material in the hardness measurements and in tensile strength determination, there is a wide variation in the values that are obtained by conversion. The tensile strength values obtained by conversion in accordance with this standard shall, therefore, be considered only as approximate values which in no case will replace the values determined by actual tensile test.

TABLE 1 CONVERSION FOR NON AUSTENITIC STEEL

[*Clause* 1.1 (a)]

Tensile Strength N/mm^2	Vickers Hardness	Brinell Hardness	Rockwell Hardness							
	HV	HB	HRB	HRF	HRC	HRA	HRD	HR15N	HR30N	HR45N
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
255	80	76.0	—	—	—	—	—	—	—	—
270	85	80.7	41.0	—	—	—	—	—	—	—
285	90	85.5	48.0	82.6	—	—	—	—	—	—
305	95	90.2	52.0	—	—	—	—	—	—	—
320	100	95.0	56.2	87.0	—	—	—	—	—	—
335	105	99.8	—	—	—	—	—	—	—	—
350	110	105	62.3	90.5	—	—	—	—	—	—
370	115	109	—	—	—	—	—	—	—	—
385	120	114	66.7	93.6	—	—	—	—	—	—
400	125	119	—	—	—	—	—	—	—	—
415	130	124	71.2	96.4	—	—	—	—	—	—
430	135	128	—	—	—	—	—	—	—	—
450	140	133	75.0	99.0	—	—	—	—	—	—
465	145	138	—	—	—	—	—	—	—	—
480	150	143	78.7	101.4	—	—	—	—	—	—
495	155	147	—	—	—	—	—	—	—	—
510	160	152	81.7	103.6	—	—	—	—	—	—
530	165	156	—	—	—	—	—	—	—	—
545	170	162	85.0	105.5	—	—	—	—	—	—
560	175	166	—	—	—	—	—	—	—	—
575	180	171	87.1	107.2	—	—	—	—	—	—
595	185	176	—	—	—	—	—	—	—	—
610	190	181	89.5	108.7	—	—	—	—	—	—
625	195	185	—	—	—	—	—	—	—	—
640	200	190	91.5	110.1	—	—	—	—	—	—

660	205	195	92.5	—	—	—	—	—	—	—
675	210	199	93.5	111.3	—	—	—	—	—	—
690	215	204	94.0	—	—	—	—	—	—	—
705	220	209	95.0	112.4	—	—	—	—	—	—
720	225	214	96.0	—	—	—	—	—	—	—
740	230	219	96.7	113.4	—	—	—	—	—	—
755	235	223	—	—	—	—	—	—	—	—
770	240	228	98.1	114.3	20.3	60.7	40.3	69.6	41.7	19.9
785	245	233	—	—	21.3	61.2	41.1	70.1	42.5	21.1
800	250	238	99.5	115.1	22.2	61.6	41.7	70.6	43.4	22.2
820	255	242	—	—	23.1	62.0	42.2	71.1	44.2	23.2
835	260	247	(101)	—	24.0	62.4	43.1	71.6	45.0	24.3
850	265	252	—	—	24.8	62.7	43.7	72.1	45.7	25.2
865	270	257	(102)	—	25.6	63.1	44.3	72.6	46.4	26.2
880	275	261	—	—	26.4	63.5	44.9	73.0	47.2	27.1
900	280	266	(104)	—	27.1	63.8	45.3	73.4	47.8	27.9
915	285	271	—	—	27.8	64.2	46.0	73.8	48.4	28.7
930	290	276	(105)	—	28.5	64.5	46.5	74.2	49.0	29.5
950	295	280	—	—	29.2	64.8	47.1	74.6	49.7	30.4
965	300	285	—	—	29.8	65.2	47.5	74.9	50.2	31.1
995	310	295	—	—	31.0	65.8	48.4	75.6	51.3	32.5
1 030	320	304	—	—	32.2	66.4	49.4	76.2	52.3	33.9
1 060	330	314	—	—	33.3	67.0	50.2	76.8	53.6	35.2
1 095	340	323	—	—	34.4	67.6	51.1	77.4	54.4	36.5
1 125	350	333	—	—	35.5	68.1	51.9	78.0	55.4	37.8
1 155	360	342	—	—	36.6	68.7	52.8	78.6	56.4	39.1
1 190	370	352	—	—	37.7	69.2	53.6	79.2	57.4	40.4
1 220	380	361	—	—	38.8	69.8	54.4	79.8	58.4	41.7
1 255	390	371	—	—	39.8	70.3	55.3	80.3	59.3	42.9
1 290	400	380	—	—	40.8	70.8	56.0	80.8	60.2	44.1

(*Continued*)

TABLE 1 CONVERSION FOR NON AUSTENITIC STEEL — *Contd*

Tensile Strength N/mm^2	Vickers Hardness	Brinell Hardness	Rockwell Hardness							
	HV	HB	HRB	HRF	HRC	HRA	HRD	HR15N	HR30N	HR45N
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
1 320	410	390	—	—	41.8	71.4	56.8	81.4	61.1	45.3
1 350	420	399	—	—	42.7	71.8	57.5	81.8	61.9	46.4
1 385	430	409	—	—	43.6	72.3	58.2	82.3	62.7	47.4
1 420	440	418	—	—	44.5	72.8	58.8	82.8	63.5	48.4
1 455	450	428	—	—	45.3	73.3	59.4	83.2	64.3	49.4
1 485	460	437	—	—	46.1	73.6	60.1	83.6	64.9	50.4
1 520	470	447	—	—	46.9	74.1	60.7	83.9	65.7	51.3
1 555	480	(456)	—	—	47.7	74.5	61.3	84.3	66.4	52.2
1 595	490	(466)	—	—	48.4	74.9	61.6	84.7	67.1	53.1
1 630	500	(475)	—	—	49.1	75.3	62.2	85.0	67.7	53.9
1 665	510	(485)	—	—	49.8	75.7	62.9	85.4	68.3	54.7
1 700	520	(494)	—	—	50.5	76.1	63.5	85.7	69.0	55.6
1 740	530	(504)	—	—	51.1	76.4	63.9	86.0	69.5	56.2
1 775	540	(513)	—	—	51.7	76.7	64.4	86.3	70.0	57.0
1 810	550	(523)	—	—	52.3	77.0	64.8	86.6	70.5	57.8
1 845	560	(532)	—	—	53.0	77.4	65.4	86.9	71.2	58.6
1 880	570	(542)	—	—	53.6	77.8	65.8	87.2	71.7	59.3
1 920	580	(551)	—	—	54.1	78.0	66.2	87.5	72.1	59.9
1 955	590	(561)	—	—	54.7	78.4	66.7	87.8	72.7	60.5
1 995	600	(570)	—	—	55.2	78.6	67.0	88.0	73.2	61.2
2 030	610	(580)	—	—	55.7	78.9	67.5	88.2	73.7	61.7
2 070	620	(589)	—	—	56.3	79.2	67.9	88.5	74.2	62.4
2 105	630	(599)	—	—	56.8	79.5	68.3	88.8	74.6	63.0
2 145	640	(608)	—	—	57.3	79.8	68.7	89.0	75.1	63.5
2 180	650	(618)	—	—	57.8	80.0	69.0	89.2	75.5	64.1

—	660	—	—	—	58.3	80.3	69.4	89.5	75.9	64.7
—	670	—	—	—	58.8	80.6	69.8	89.7	76.4	65.3
—	680	—	—	—	59.2	80.8	70.1	89.8	76.8	65.7
—	690	—	—	—	59.7	81.1	70.5	90.1	77.2	66.2
—	700	—	—	—	60.1	81.3	70.8	90.3	77.6	66.7
—	720	—	—	—	61.0	81.8	71.5	90.7	78.4	67.7
—	740	—	—	—	61.8	82.2	72.1	91.0	79.1	68.6
—	760	—	—	—	62.5	82.6	72.6	91.2	79.7	69.4
—	780	—	—	—	63.3	83.0	73.3	91.5	80.4	70.2
—	800	—	—	—	64.0	83.4	73.8	91.8	81.1	71.0
—	820	—	—	—	64.7	83.8	74.3	92.1	81.7	71.8
—	840	—	—	—	65.3	84.1	74.8	92.3	82.2	72.2
—	860	—	—	—	65.9	84.4	75.3	92.5	82.7	73.1
—	880	—	—	—	66.4	84.7	75.7	92.7	83.1	73.6
—	900	—	—	—	67.0	85.0	76.1	92.9	83.6	74.2
—	920	—	—	—	67.5	85.3	76.5	93.0	84.0	74.3
—	940	—	—	—	68.0	85.6	76.9	93.2	84.4	75.4

NOTE 1 — The hardness values given in brackets for Rockwell B scale are outside the range of definition of standardized hardness test methods and should be considered as approximate.

NOTE 2 — The Brinell hardness values given in brackets are applicable only when determined with a hard metal ball.

NOTE 3 — For Brinell hardness values given in this table, $\frac{0.102F}{D^2}$ ratio of 30 is applicable, and for the Vickers hardness values the load F ≥ 98N (10 kgf) was used.

TABLE 2 CONVERSIONS FOR ALUMINIUM AND ITS ALLOYS

[*Clause* 1.1 (b)]

VICKERS HARDNESS HV (1)	BRINELL HARDNESS HB (2)	ROCKWELL HARDNESS HRB (3)	VICKERS HARDNESS HV (1)	BRINELL HARDNESS HB (2)	ROCKWELL HARDNESS HRB (3)	VICKERS HARDNESS HV (1)	BRINELL HARDNESS HB (2)	ROCKWELL HARDNESS HRB (3)
210	199.5	95.7	98	93.1	50.8	58	55.1	—
205	194.3	94.8	96	91.2	49.1	56	53.2	—
200	190.0	93.8	94	89.3	47.2	54	51.3	—
195	185.3	92.7	92	87.4	45.3	52	49.4	—
190	180.5	91.6	90	85.5	43.3	50	47.5	—
185	175.8	90.4	88	83.6	41.3	48	45.6	—
180	171.0	89.2	86	81.7	39.1	46	43.7	—
175	166.3	87.9	84	79.8	36.8	44	41.8	—
170	161.5	86.5	82	77.9	34.4	42	39.9	—
165	156.8	85.0	80	76.0	31.9	40	38.0	—
160	152.0	83.4	78	74.1	—	38	36.1	—
155	147.3	81.8	76	72.2	—	36	34.2	—
150	142.5	80.0	74	70.3	—	34	32.3	—
145	137.8	78.1	72	68.4	—	32	30.4	—
140	133.0	76.1	70	66.5	—	30	28.5	—
135	128.3	73.9	68	64.6	—	28	26.6	—
130	123.5	71.5	66	62.7	—	26	24.7	—
125	118.8	69.0	64	60.8	—	24	22.8	—
120	114.0	66.3	62	58.9	—	22	20.9	—
115	109.3	63.3	60	57.0	—	20	19.0	—
110	104.5	60.0	—	—	—	18	17.1	—
105	99.8	56.4	—	—	—	—	—	—
100	95.0	52.5	—	—	—	—	—	—

NOTE — For the Vickers hardness values given in this table a load of F = 98 N (10 kgf) and for the Brinell hardness values the $\frac{0.102F}{D^2}$ ratio of 5 or 10 are applicable.

TABLE 3 CONVERSIONS FOR SOFT ALUMINIUM ALLOYS

[*Clause* 1.1 (b)]

BRINELL HARDNESS	ROCKWELL HARDNESS	ROCKWELL HARDNESS
HB	HRE	HRH
74	80	—
72	79	—
70	77	99
68	75.5	98
66	73.5	97
64	72	96
62	69.5	94.5
60	67	93
58	64.5	91.5
56	61.0	89.5
54	58.0	87.8
52	..	86
48	..	84
46	..	80
44	—	77.8
42	—	75.7
40	—	73.5
38	—	71.3
36	—	68.8
34	—	64.8
32	—	60.8
30	—	57
28	—	52
26	—	46
24	—	40.2
22	—	35.4
20	—	29.5
18	—	19.5

NOTE — For the Brinell hardness values, the $\frac{0.102F}{D^2}$ ratio of 5 or 10 is applicable.

TABLE 4 CONVERSIONS FOR COPPER AND BRASS (ZINC UP TO 30 PERCENT)

[*Clause* 1.1 (c)]

VICKERS HARDNESS HV	BRINELL HARDNESS HB $\frac{0.102F}{D^2} = 10$	ROCKWELL HARDNESS HRB	VICKERS HARDNESS HV	BRINELL HARDNESS HB $\frac{0.102F}{D^2} = 10$	ROCKWELL HARDNESS HRB
(1)	(2)	(3)	(1)	(2)	(3)
210	199.5	95.7	88	83.6	41.3
205	194.8	94.8	86	81.7	39.1
200	190.0	93.8	84	79.8	36.8
195	185.3	92.7	82	77.9	34.4
190	180.5	91.6	80	76.0	31.9
185	175.8	90.4	78	74.1	—
180	171.0	89.2	76	72.2	—
175	166.3	87.9	74	70.3	—
170	161.5	86.5	72	68.4	—
165	156.8	85.0	70	66.5	—
160	152.0	83.4	68	64.6	—
155	147.3	81.8	66	62.7	—
150	142.5	80.0	64	60.8	—
145	137.8	78.1	62	58.9	—
140	133.0	76.1	60	57.0	—
135	128.3	73.9	58	55.1	—
130	123.5	71.5	56	53.2	—
125	118.8	69.0	54	51.3	—
120	114.0	66.3	52	49.4	—
115	109.3	63.3	50	47.5	—
110	104.5	60.0	48	45.6	—
105	99.8	56.4	46	43.7	—
100	95.0	52.5	44	41.8	—
98	93.1	50.8	42	39.9	—
96	91.2	49.1	40	38.0	—
94	89.3	47.2	38	36.1	—
92	87.4	45.3	36	34.2	—
90	85.5	43.3	34	32.3	—

NOTE — For the Vickers hardness values given in this table a load of $F = 98$ N (10 kgf) and for the Brinell hardness values, the $\frac{0.102F}{D^2}$ ratio of 5 or 10 are applicable.

INDIAN STANDARDS

ON

PHYSICAL TESTING

IS:

1500-1968	Method for Brinell hardness test for steel (*first revision*)
1501-1968	Method for Vickers hardness test for steel (*first revision*)
1586-1968	Method for Rockwell hardness test (B and C scales) for steel (*first revision*)
1754-1968	Method for verification of Vickers hardness testing machines (*first revision*)
1789-1961	Method for Brinell hardness test for grey cast iron
1790-1961	Method for Brinell hardness test for light metals and their alloys
1810-1961	Method for Vickers hardness test for light metals and their alloys
2281-1968	Method for verification of Brinell hardness testing machines (*first revision*)
2866-1965	Method for Vickers hardness test for copper and copper alloys
3054-1965	Method for Brinell hardness test for copper and copper alloys
3754-1967	Method for calibration of standardized blocks to be used for Rockwell B and C scale hardness testing machines
3803-1974	Method for elongation conversions for steel (*first revision*)
3804-1966	Method for calibration of Rockwell B and C scale hardness testing machines
4132 1967	Method for calibration of standardized blocks to be used for Brinell hardness testing machines
4133-1967	Method for calibration of standardized blocks to be used for Vickers hardness testing machines
5072-1969	Method for Rockwell superficial hardness test (N and T scale) for steel
5073-1969	Verification of Rockwell superficial hardness (N and T scale) hardness testing machines
5076-1969	Method for calibration of standardized blocks to be used for Rockwell (N and T scale) hardness testing machines
7095-1973	Method for verification of knoop hardness testing machines
7096-1973	Method for shore hardness test for metallic materials
7097 1973	Method for calibration of standardized blocks to be used for testing knoop hardness testing machines
7172-1974	Shore hardness testing machines (anvil type) and their verification
9258-1979	Method for Vickers micro hardness testing of metals

This Indian Standard has been developed by Technical Committee : SMDC 3

Amendments Issued Since Publication

Amend No.	Date of Issue
Amd. No. 1	December 1984

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